Polyimide Film Antenna Deployment for a Pathfinder Lunar Radio Observatory

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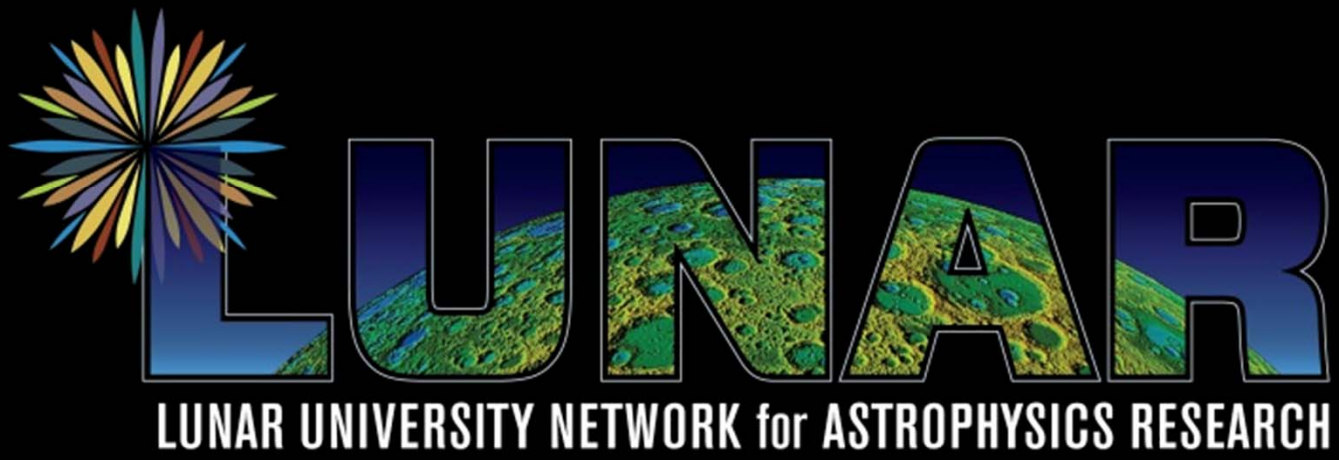
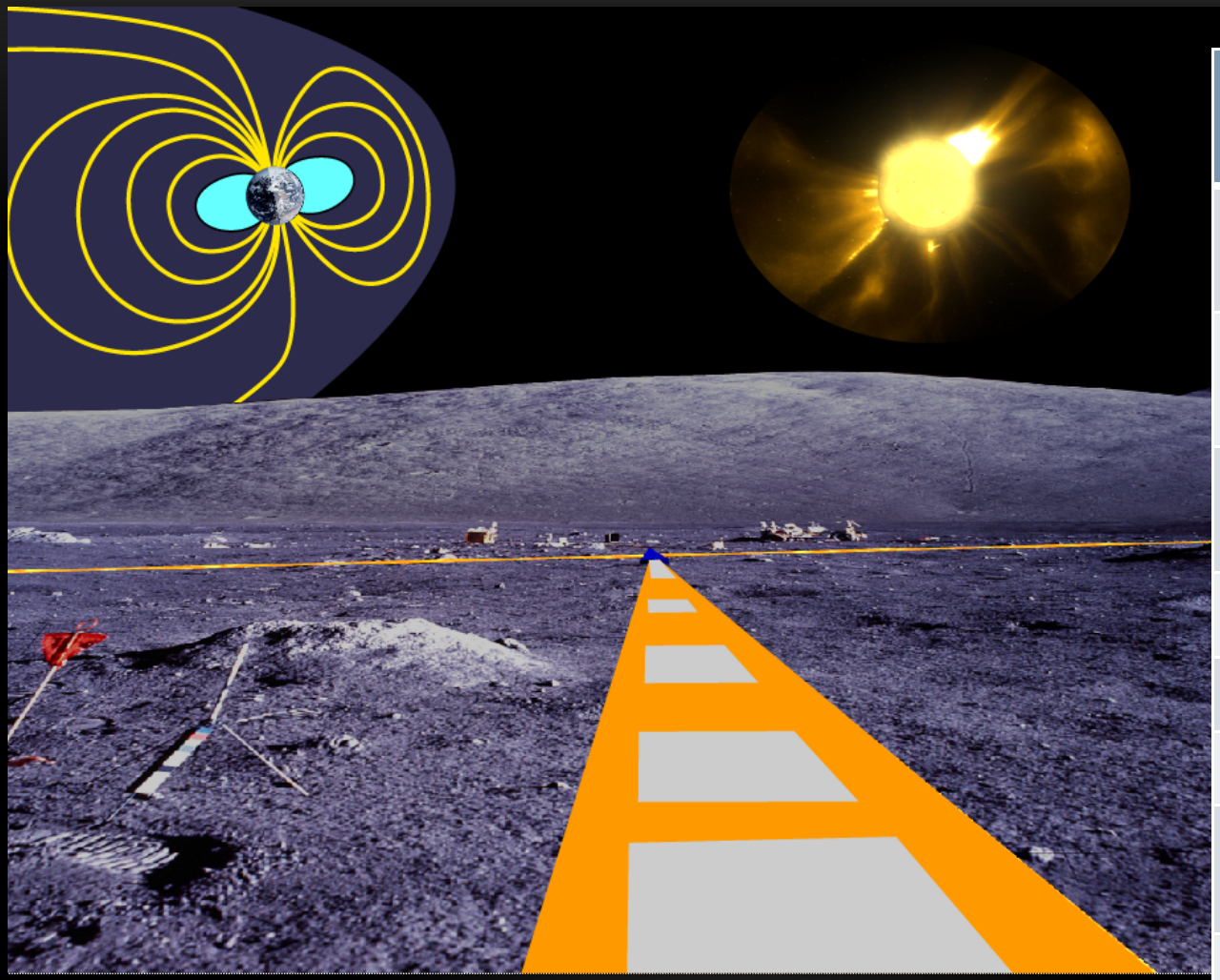


Introduction

- A first step in the development of a large radio observatory on the moon for cosmological or other astrophysical and planetary goals may be to deploy a few antennas as a pathfinder mission.
- We describe a mechanism being developed to deploy such antennas from a small craft, such as a Google Lunar X-prize lander.
- The antenna concept is to deposit antennas and leads on a polyimide film, such as Kapton, and to unroll the film on the lunar surface.
- The deployment technique presented here is to launch an anchor which pulls a double line from a reel on the lander. Then, reeling in the line pulls out the film.
- Other deployment techniques include pressurizing a film tube, rover deployment, etc.
- The pathfinder would detect the low frequency cutoff of the galactic radio background or of solar radio bursts which would determine the time-variation of the lunar ionospheric density.

Radio Observatory on the Lunar Surface for Solar studies



ROLSS
Wavelength (Frequency)
30–300 m (1–10 MHz)
Angular Resolution
2º (at 10 MHz)
Bandwidth
≤ 100 kHz
Minimum Lifetime
1 yr

See Lazio et al., Adv. Space Res., 48, 2011

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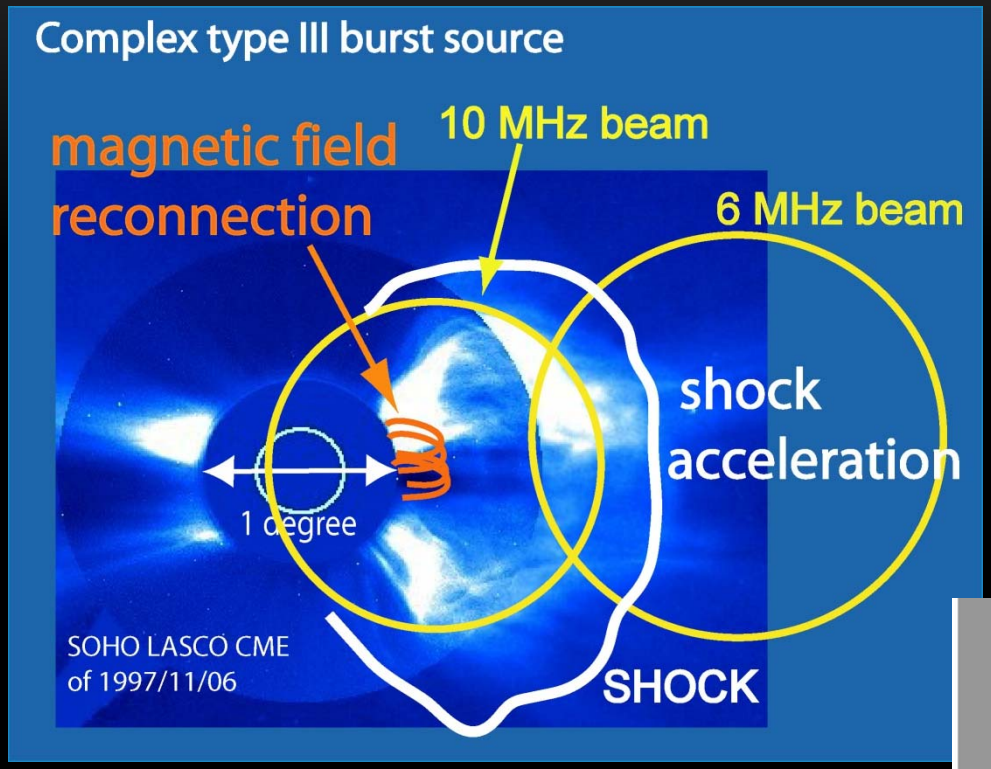
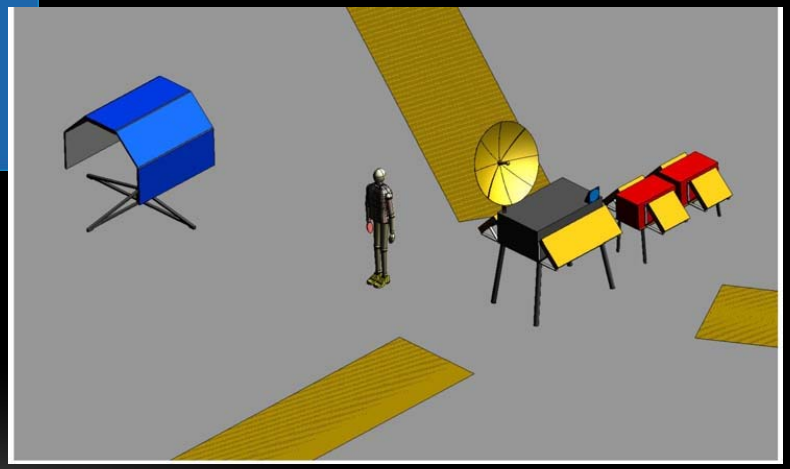
ROLSS images solar radio bursts

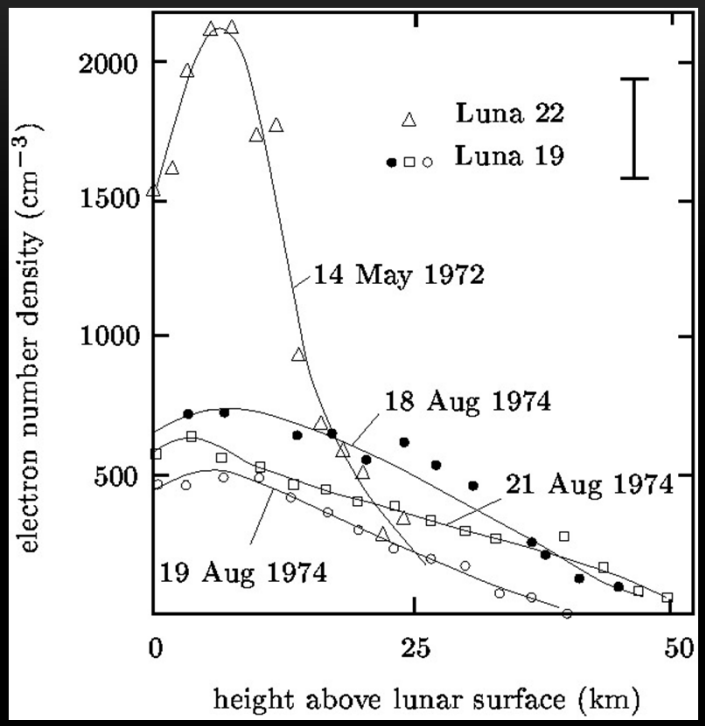


Below, the Central Electronics Package (CEP) is shown with solar arrays, high gain antenna, boxes (red) for batteries, 3 polyimide antenna arms, and human (for scale) – concept based on Instrument Design Lab study (GSFC)



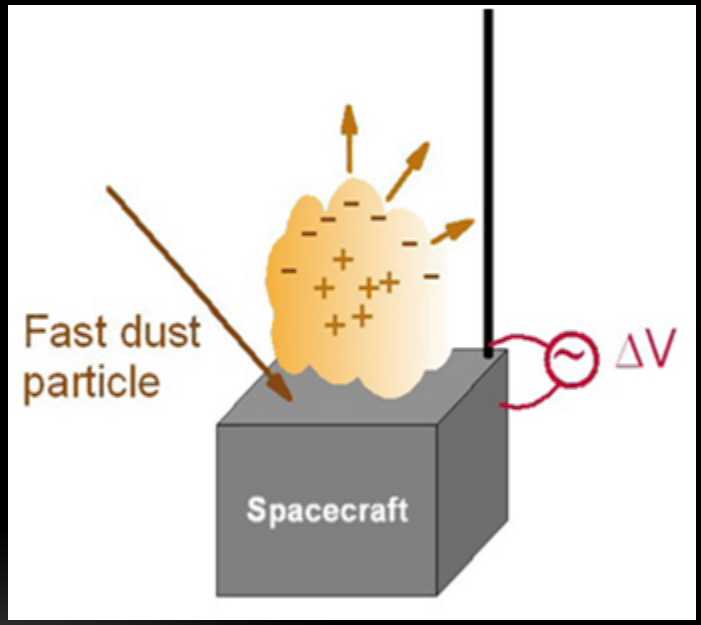
ROLSS determines if complex type III bursts are caused by shock acceleration of electrons or by reconnection energization.

ROLSS also detects lunar ionosphere & IP/IS dust



Lunar ionosphere electron density data from Luna 19 and Luna 22 missions. Note the large variations between days, and the large peak electron density on 14 May 1972. ROLLS or its pathfinder will measure maximum electron density vs. time.

We have considerable experience with the electrical signature of interplanetary (IP) and interstellar (IS) dust striking a spacecraft. The large ROLSS antennas will serve as an electrostatic dust detector with 1500 m^2 collecting area.



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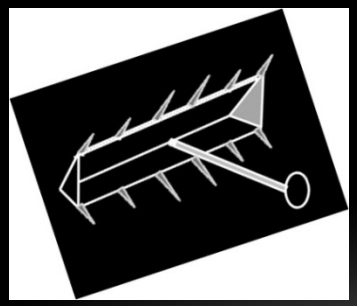
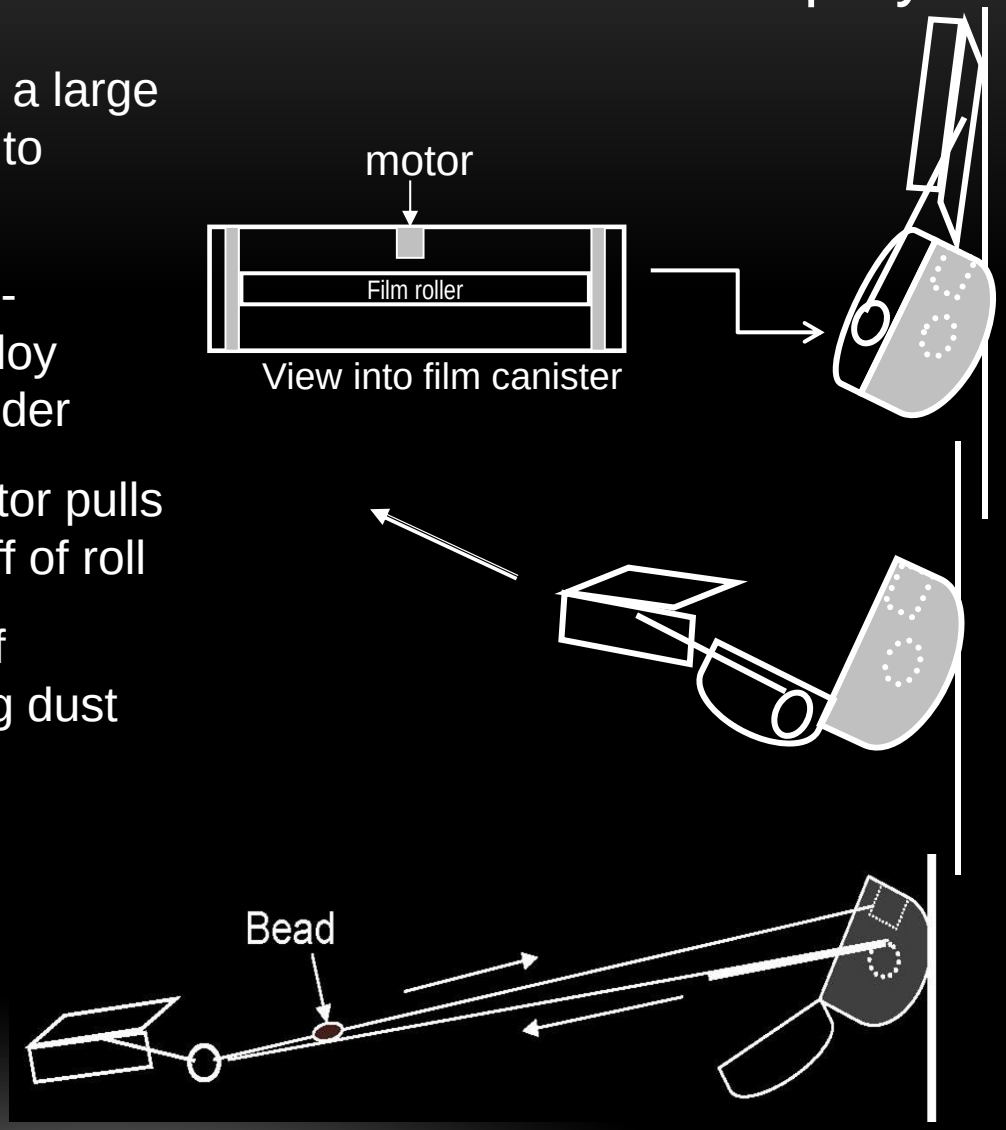
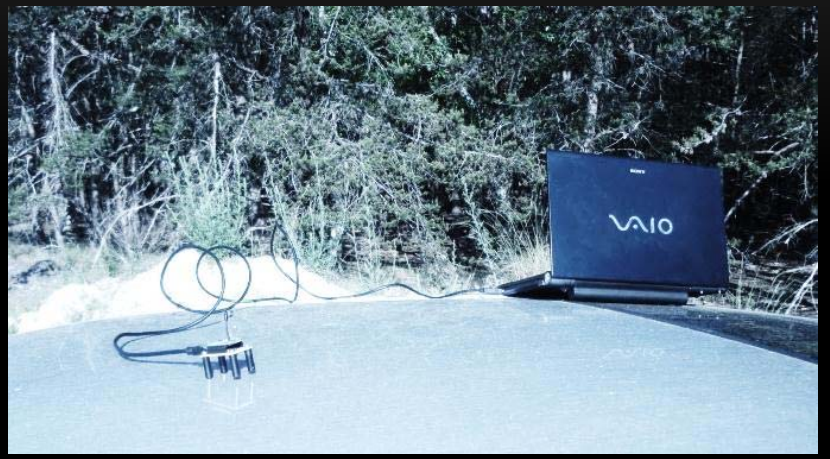
Concept and Test Model for Anchor-Based Film Deployer

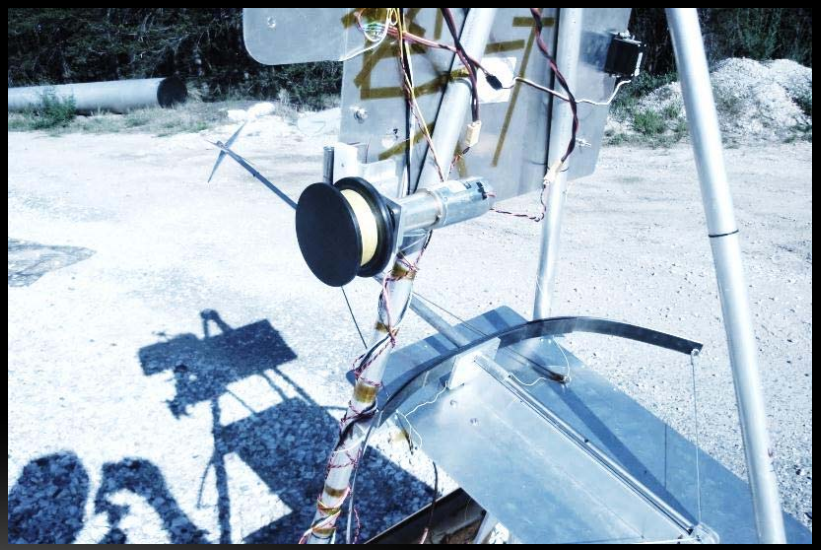
- A 1st step in the development of a large lunar radio observatory may be to deploy a small pathfinder
- Concept at right shows a spring-launched anchor system to deploy polyimide film for such a pathfinder
- Once anchor has deployed, motor pulls in line, pulling film &antennas off of roll
- "Fractal" anchor reduces risk of anchor not holding, by collecting dust or catching on larger debris





Deployer setup at Goddard Geophysical & Astronomical Observatory





Anchor launch

Motor pulling in line

Film starts to deploy

Deployment (slowly) nearing completion

Deployment considerations

- Wind will readily lift film (see above)
- Testing inside hanger/warehouse may be needed
- Not a problem on Moon, but need to be able to conduct testing on the ground.
- Must also study ability to handle rougher terrain.

Summary

- New version of ROLSS Pathfinder anchor deployer ready to test with Kapton film; testing planned for summer interns.
- A month of low to moderate wind speed at Greenbelt delayed testing; never a calm day
- Points to a test problem for light to medium weight Kapton film – truly calm days are not common; consider night deploys?
- Finally able to test successfully in a more shielded, forested area – Goddard Geophysical & Astronomical Obs. (GGAO)
- Also working on comparison of alternate deployment methods: inflatable Kapton tube, robotic micro-rover replacing anchor, …